Remsen (I.)

[*Reprinted from the Transactions of the Medical and Chirurgical Faculty of Maryland, April,* 1878.]

THE ANNUAL ORATION.

Chemistry in its Relations to Medicine.

BY

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BALTIMORE:

INNES & COMPANY, PRINTERS AND BINDERS.

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CHEMISTRY IN ITS RELATIONS TO MEDICINE.

By Prof. Ira Remsen, of the Johns Hopkins University.

Eleven years ago, in company with ninety-nine others, I was proclaimed fit to enter upon the career of a medical man. My erudition in medical matters was exhibited in a thesis on "Fatty Degeneration of the Liver," a subject of which I was and am profoundly ignorant. I had in fact never seen a liver which had undergone fatty degeneration, nor a patient who possessed, or was supposed to possess one; nor, I may add, have I had that pleasure up to this day. Two weeks after graduation as a Doctor of Medicine I commenced the special study of chemistry, and have continued ever since to prosecute the study. These facts are certainly not of grave importance, but I feel called upon to relate them, in order that I may not be subjected to the suspicion of appearing before you under false colors. Let me introduce my remarks then by the emphasized statement, "I am not a medical man." Hence it would be very presumptuous in me to attempt, on this occasion, to give a medical address, in the narrower sense of that expression. And yet I fancy my remarks should have some connection with the matters which occupy you daily, that they may possess a living interest. I am thus, as you will see, comparatively restricted in choosing a theme, as the first condition to be satisfied is certainly that I, at least, should know what I am talking about. By a very rapid process of elimination then, I am led immediately to the subject which I have chosen, viz: "Chemistry in its relations to Medicine." I confess that the subject is a very

broad one, that can not possibly be treated in anything like an exhaustive way in a short time. The subject is also rather hackneyed: nevertheless it is a good subject, and I only wish I could be sure to do it justice.

I shall not undertake to prove what is already well known, that a knowledge of chemistry is valuable for the physician, that chemistry is intimately connected with medicine, &c. These are well established facts, acknowledged by every one; though perhaps not always with a full appreciation of all that is involved in them. As far as possible I shall endeavor to avoid those points which are usually considered under the head I have chosen, and to ask your attention to a few matters of special interest, suggested more particularly by some recent investigations and discoveries in the field of chemistry. This I shall do partly for the sake of the investigations and discoveries themselves, but also, to a great extent, for the sake of the morals to be drawn from their consideration. It is true that the influence exerted upon medicine by chemistry is of many kinds, and that it deserves consideration from many sides. I shall, however, confine myself to only a few points.

If we look back over the field of chemistry, we find that we can easily discern well characterized periods in its development. At first, in this subject, as in all others, came the period of chaos, during which relations of similar facts were not recognized nor suspected. No defined object was in view; and the development during this period was due almost entirely to accidental observations of facts which presented themselves to men in pursuing their ordinary occupations. Gradually we find that a certain class of men began to make use of chemical facts, as far as they were then known, for a very definite purpose. This was to convert ordinary base metals into that metal which possessed the greatest value — gold. This purpose gave a powerful incentive to the study of chemical phenomena, and under the influence of the natural passion which affected a comparatively large number of men, the subject of chemistry grew apace. But the impossibility of accomplishing the great problem of the Alchemists became more and more apparent. No gold *was* made from baser metals, and no genuine philosopher's stone was discovered; no panacea for all

diseases was revealed. A reaction in scientific opinion then began, which led to very much modified views concerning the purpose of chemistry, until about the time of Paracelsus, who was both physician and chemist, we find that the opinion prevailed very generally among those who were most active in investigating chemical phenomena, that the changes which take place in the animal body, under normal conditions, are nothing but chemical changes; that a disturbance of these normal changes causes the different varieties of disease; and, finally, that the treatment of disease must consist in administering such chemical substances as would restore the normal conditions. Paracelsus started these ideas, and others developed them, until they took the exaggerated form comprised in the above statements. According to these ideas, medicine was considered as a branch of chemistry, very much as metallurgy is now considered as a branch of chemistry. Hence, the physicians of the date of which I am speaking, *i. e.* from the early part of the sixteenth until some time in the seventeenth century, regarded chemistry as the one important subject for those who were to deal with disease. Without a knowledge of this subject they could not comprehend the processes of life; without it they could not understand disease; without it they could not intelligently administer remedies.

I think we can see in this reference to history a tendency which has frequently been repeated since that time; a tendency to generalize upon an insufficient basis of facts concerning the action of remedies. The reasoning of these older physicians, stripped of all unnecessary details, was simply this: Some remedies act chemically upon the body and produce chemical effects, hence all remedies must act in the same way. Thus the chemico-medical school was founded as many schools of medicine have since been founded. The dogmas of this old school contained a healthy nucleus of truth to be sure, as do the dogmas of most schools of medicine existing at the present day; but the physician proper now recognizes that remedies act in very many ways, and that the science of medicine must take into consideration every way in which remedies can act. He does not commit the error of being satisfied with one idea, as for instance that substances do act chemically upon the

body, that cold water is a valuable remedy, that electricity properly applied is at times beneficial. A single idea is not sufficient for him.

Still we must recognize the fact that, in order to impress upon the minds of men the importance of an idea, in order to attract attention to it, it is frequently necessary to present it in an exaggerated form. And so, while we see the error of the old physicians of Paracelsus's time, we see also that, by attracting the attention of physicians and chemists to the connection between chemistry and medicine, the error committed resulted in permanent good to medicine, and the influence of the old school is still felt. The ideas of those who founded and developed the chemico-medical school have found their proper level, as all ideas tend to do sooner or later.

It would doubtless be interesting to follow closely the history of the connection between chemistry and medicine, but our time will not permit the discussion of this subject, and hence I shall speak of the bonds of connection, indicated by actual chemical work of the present day.

In the first place, chemistry furnishes medicine with many of its valuable remedies, as every one knows. The chemist, however, does not recognize the discovery of new substances, possessed of medicinal properties, as the object of his work. If he did so, both chemistry and medicine would suffer. The prime object of the scientific chemist must always be to develop his science, to perfect it in every way he may find possible; he must be constantly on the look-out for discrepancies between facts supposed to be established, and must ever endeavor to correct errors into which his predecessors may have fallen; he must reach out beyond that which is known and strive to know more. The object of the chemist can only be accomplished by employing every method peculiar to the science of chemistry, and by striving to know everything about a substance or class of substances which it is possible to discover. If the chemist should work with the main object of adding to the valuable substances included in the Materia Medica, he would stop when he had established the fact that this substance—just born—has such and such medicinal properties.

He might discover a few substances in this way, but, unless work of another kind were going on simultaneously, which would furnish him with new methods, with new guiding principles, the possibilities of new discoveries would soon be exhausted. It is absolutely necessary then that purely scientific and abstruse problems should engage the attention of chemists, if the science is to grow ; and it is further necessary that the science should grow in order that new methods for the discovery of new substances may be introduced. It is the chemist proper who furnishes the new methods ; it may be that the chemist proper also discovers the valuable remedy, though one who simply applies the truths of chemistry *may* make the discovery.

As a matter of fact, it can be shown that it is to the purely scientific chemist, working with the main object of building up the science, that we owe the discovery of most valuable remedies, at least of those which are strictly speaking chemical compounds. I select for this purpose two substances which have but comparatively recently found their places in the Materia Medica, viz. : chloral and salicylic acid. How, and by whom were these substances discovered and introduced into medicine?

Nearly fifty years ago, the great master Liebig undertook the study of the decomposition which alcohol undergoes when treated with chlorine. Other observers had noticed the fact that alcohol is decomposed by chlorine and that an oily product is formed, but the nature and composition of this product were unknown. Liebig undertook then simply to study this decomposition for the sake of throwing light upon the general subject, the action of chlorine upon alcohols. His investigations soon led him to the discovery of a new substance which possessed peculiar chemical properties, distinguishing it from all other compounds then known. This was *chloral*, the name being derived from the first syllable of *chlor*ine and the first syllable of *al*cohol. Of the action of this substance upon the system, Liebig did not dream ; but the study of its properties, which he made at that time, furnished the material that enabled Liebreich, forty years later, to dream in a very rational manner concerning its action upon the system. Liebreich's discovery of the value of chloral could not have been made by one

unversed in chemistry. His experiments were undertaken in the true scientific spirit, and were suggested by a purely chemical method of consideration.

Among other facts concerning chloral which had been established by Liebig was this, that in the presence of alkalies it breaks up into formic acid and the substance which we now know by the name of chloroform. Chloroform was thus discovered by Liebig at the same time with chloral, but the action of the former upon the system was as little known as that of the latter. Years after the effects produced by the inhalation of chloroform were discovered, Liebreich reasoned thus: If chloral breaks up in alkaline liquids into chloroform and formic acid, why should it not break up in the same way when introduced into the animal system? The conditions in the body are favorable for such a decomposition; the blood is an alkaline liquid and the chloral will dissolve in it. By means of this reasoning the discovery was made, and there is no cause to doubt that the beneficial effects experienced from chloral are due to the fact that the alkaline blood decomposes it, forming chloroform and formic acid, the chloroform being thus introduced into the system in a manner differing from that involved in the inhalation process.

As regards salicylic acid, its discovery was the result of a long series of purely scientific investigations. For years Kolbe had been trying to produce artificially in his laboratory some of the substances which are found in nature. He strove faithfully and conscientiously to accomplish his purpose, and at last he discovered a method which enabled him to make oxalic acid; and then, after the method was given, the production of other similar acids was simply a question of the application of the new method. Salicylic acid was among the products thus formed. The acid had been known for a long time, but as it could be obtained only from the expensive oil of wintergreen, it belonged to the rare substances. Kolbe's method of preparation, however, furnished the substance in large quantity and at a low price.

The discovery of the valuable antiseptic properties of the acid was a pure scientific discovery, and was due to purely chemical reasoning. It was known that salicylic acid when heated breaks

up directly into carbolic acid and what is commonly called carbonic acid. It occurred to Kolbe that possibly this property might be taken advantage of to furnish a substitute for the objectionable carbolic acid. The results of his experiments are well known; they were more satisfactory than he had hoped for. He found that salicylic acid is an excellent antiseptic. Though he has shown that, contrary to his expectation, the antiseptic action possessed by the acid is not due to its breaking up into carbonic and carbolic acids, still the action must be due to a similarity between the chemical structures of the two acids, and this similarity could not have been detected without the aid of some of the most refined methods of scientific chemistry. It is safe to say that blind experiment, unguided by definite chemical principles, could not have led to this discovery.

Thus I have at least illustrated the truth of the remark I made a few minutes since, to the effect that the discoveries of substances valuable in medicine are made by those engaged in the pursuit of pure science. I am aware that the two examples thus referred to will not suffice to furnish a perfect proof of the proposition, but, if time permitted us to take a survey of the field, we should find that the proof could be made conclusive.

But the discovery of new substances to be used as remedies does not furnish the only bond of connection between medicine and chemistry. Nor is it by any means the most important one; for as the tendency of the present generation of physicians is, I think, to rely less and less upon the action of drugs and chemicals, and to pay more and more attention to the circumstances surrounding the patient, so the discovery of purely remedial agents is becoming day by day of less importance, and the accurate study of those substances which we all necessarily make use of—air, water, food in its various forms—is becoming the great problem in medicine. Thank Heaven! the day of the old woman who knows what is "good for" everything is waning. She exists still in a thousand forms, sometimes in skirts and sometimes in trousers, but the natural growth of modern ideas will eradicate her, though the process will take generations for its completion.

What is pure air? What is pure water? What food is appro-

priate? These are questions which can only be answered by him who is versed in chemistry. The very fact that discussions are still going on in regard to these subjects, indicates clearly that they cannot be answered easily, and yet no one doubts their fundamental importance.

For years men were satisfied with the belief that an increase in the amount of carbonic acid beyond a certain point was the cause of the evil effects experienced in breathing "foul air." The old familiar stories that have been told to prove the injurious character of the gas are still told in lectures on chemistry and text-books of chemistry, and in medical books without number. Still, as most of you probably know, it has long since been proved by direct experiment, beyond the possibility of a doubt, that the amount of this gas may be increased to $\frac{1}{20}$ of the volume of the air without producing any serious or even disagreeable effects upon those who breathe the air thus contaminated. This is true, however, only when the carbonic acid is mixed with the air as a pure substance. If introduced in the ordinary way, by the breathing process, different results are obtained, and it is found that under these circumstances the quantity of carbonic acid can not exceed 1 part in 1000 of air, without serious effects upon those who breathe the air. The two results apparently do not harmonize. But when we recognize the presence of other substances—of organic matters—in the air, which are given off from the body together with the carbonic acid, and in quantities proportional to the quantities of the latter, we can readily see that there may be some connection between the amount of the carbonic acid present and the fitness of the air for breathing purposes. Such organic matters can easily be detected in the air, and they have recently been found by a method which indicates the possibility of determining their quantity, though such determinations are, at present, far from possible. Air was passed through a heated tube and then passed into alcohol for the purpose of retaining the products formed by heating the organic substances. The alcohol gradually changed its color and became dark brown. This experiment, though exceedingly imperfect, at present points, I think, to the possibility of estimating the purity of air by a direct determination of the quantities of those constituents which

probably are the really injurious ones; while, at present, for the want of a more reliable method we are obliged to be satisfied with determining the quantity of carbonic acid, and then drawing conclusions with reference to the amount of the organic matters present.

Various attempts have been made to simplify the determination of the amount of carbonic acid in air, so that even those who are not skilled in chemical manipulation might have a ready means for pronouncing upon the quality of air. The simplest of the methods proposed is the minimetric process of Lunge, which has been used to some extent in this as well as other countries. To show you, however, in what an unsatisfactory state this matter of air analysis still is, I will simply say that experiments undertaken within a few months by Hesse* have shown that Lunge's minimetric process does not give reliable results, and hence conclusions reached from determinations made by this method are not to be regarded as final.

Another point still in dispute concerns the presence of carbonic oxide in the air. This lower oxide of carbon is undoubtedly poisonous, and cannot be taken into the lungs without serious effects. The presence of only a small proportion of this gas will suffice to produce death. Now if it could be shown that there are certain causes at work which apparently tend to introduce the gas into our dwellings and other buildings, alarm would naturally follow. Some years ago St. Claire Deville, the French chemist, discovered that certain metals when heated to red heat are porous for certain gases. This he found to be true of cast iron with reference to carbonic oxide. It is well known that in our coal fires there is always formed a large quantity of carbonic oxide, and, further, that stoves and furnaces not uncommonly become red hot. Putting these facts together, men became alarmed. Stoves and furnaces were regarded with horror. In the eyes of many they were looked upon as poison-generators of a very dangerous kind. Active diseases were in some cases believed to have their origin in the presence of carbonic oxide in the air; and in cases in which active disease did not show itself, lassitude, headache and other similar symptoms

* Zeitschrift für Biologie, Bd. XIII, 395.

were supposed to be caused by the gas. There was a fashion in some places, and particularly among those who prided themselves on "keeping up with the times," of referring every bodily affection to carbonic oxide when no other cause could be thought of. Very much as, in days gone by, every disease which was not understood was classed under the general head, "trouble with the liver."

What basis of facts have we for this alarm about carbonic oxide? Two chemists, within a very short time, have gone to work to determine the amount of the gas contained in the air in places where it was assumed to be present in considerable quantity. And with what results? Why, the spectre vanished. In vain they sought for it—in this corner, in that, in the chimney, in the hot air passages; but it was not there. There seems to be nothing left for the carbonic-oxide alarmists but to yield, and to set about looking for another cause.

The special experiments to which I refer were carried out by Gottschalk in Leipzig, and Vogel* in Berlin. Gottschalk, in a pamphlet entitled "Ueber die Nachweisbarkeit des Kohlenoxyds in sehr kleinen Mengen, und einige Bemerkungen zu der sogenannten Luftheizungsfrage," describes a process by means of which he could detect, as he shows by direct experiment, 0.22 parts of carbonic oxide in 1000 parts of air. He was commissioned by the authorities of the city of Leipzig to apply this process to the examination of the air in two of the public schools in the city. Two different kinds of hot-air furnaces were employed in these schools, and it was supposed that the air of the rooms was certainly contaminated with carbonic oxide. The experiments, however, showed that, if present at all, the gas could not be detected by a method capable of showing with certainty the presence of .22 parts in 1000.

Vogel's experiments are not so delicate as those of Gottschalk, but still they are interesting for other reasons. His method consists in shaking the air under examination with water which contains a drop or two of blood, and then examining the liquid by means of a pocket-spectroscope. If .4 per cent. of carbonic oxide

*Berichte der deutschen chemischen Gesellschaft, XI, 235.

be present, the result is plainly perceptible in the spectrum of the light which has passed through the blood. The authorities of the city of Berlin commissioned Vogel, together with two other well known experts, to examine the air of a number of school-rooms in the city with particular reference to the presence of carbonic oxide. The conclusion was simply that none of the gas could be detected by the blood method. Vogel argues further that a quantity of carbonic oxide in the air which cannot be detected by his method, cannot act poisonously upon the concentrated blood of the human lungs.

Of course the experiments described do not prove conclusively that air is not sometimes rendered unwholesome by carbonic oxide, but they at least prove that this gas is not so widely distributed as it has been supposed to be for some time past.

Another constituent of the air which has from time to time attracted considerable attention, is ozone. This has been supposed to be a health-giving principle in the atmosphere, and magical properties have been ascribed to it. The vitality of men is known to be subject to marked variations. On a cool, clear, bracing day, man is not what he is on a warm and murky day. The quantity of ozone in the air also varies. Perhaps our moods and "spirits" are dependent upon ozone. Give us ozone enough, and the world will be happier and healthier. These are some of the ideas which have been advanced. Possibly there is some connection between these two very unlike things. Certainly much more accurate experiments than any which have thus far been made are called for to prove the connection.

In the light of many experiments it appears exceedingly probable that one of the most important constituents of the air is aqueous vapor, and that variations in its quantity beyond certain limits are productive of serious results. The actual influence of carbonic acid, carbonic oxide, or ozone, upon the value of air is almost nothing as compared with the influence exerted by the moisture. This is a point that does not ordinarily receive the amount of attention which it deserves. A reliable hygrometer should be used as frequently in a dwelling as a reliable thermometer. It is undoubtedly a very difficult thing to regulate the

amount of moisture in the atmosphere of dwellings, but more could be done than is done. The methods now adopted for this purpose are mostly exceedingly imperfect. Further, the importance of doing everything to regulate the amount is not sufficiently recognized, at least by the people at large.

As regards the water we drink, every one knows that cases are very common in which it becomes polluted in one way or another, and that disease results from its use. Innumerable chemical examinations of drinking water have been made, and large numbers of methods proposed for the analysis. Some of the methods have been shown to be utterly unreliable, others to be questionable, very few indeed to give results which can be regarded as at all valuable. It is about as difficult at the present day to say what pure water is, as it is to say what pure air is. Papers upon papers are written on the subject of water analysis. Some of them are based upon experiments performed; some are simply critical. Out of the mass of literature we gather some truths. One that stands out prominently is this, that the presence of chlorine, of organic matters, of ammonia, and of so-called "albuminoid ammonia," indicates that the water containing them is very probably contaminated through sewage, cesspool, privy or barnyard refuse. By the later methods of analysis, the estimations of the quantities of the substances mentioned have become comparatively simple processes, so that now it is undoubtedly possible to pass a fairly reliable judgment upon the value of a given specimen of water. It is, however, still quite impossible to determine by chemical methods whether the typhoid-poison is present in water or not, just as it is still impossible to determine whether in the air there is present that indefinite something known as "malaria." There is still a great deal to be done in order that a close connection between disease and the condition of drinking water may be established. The open questions are to a considerable extent chemical questions, and they must be answered by the chemist. But new methods must be introduced of a more refined nature than most of those in use at present, and these methods will probably be discovered on paths leading far away from the field of medicine proper.

There is a deep question of great importance to the physician

involved in the study of food. What food should this or that person indulge in? Every physician knows that the whole subject of food is at present in an indefinite, unsatisfactory condition. Fashions change in regard to kinds of food considered advisable. Now it is raw beef, now milk, now certain vegetables, &c. Of course there is always a good reason to be given for the advice, whatever it may be, but it is certain that a firm basis is still wanting for an understanding of the needs of the body under different conditions. Here is a great field for investigation, and Voit of Munich is doing what it is possible for a man to do in this direction.

But aside from the deeper question which chemistry must answer—as to the requirements of the body in the way of food—another question which presents itself at once to the physician and chemist concerns the adulterations of food. Very little of a general character can be said in this connection. It is, of course, the duty of the physician to see that the food partaken of is what it ought to be. That adulteration of various kinds of food is a frequent occurrence can not be doubted. In despotic countries, inspectors of food are appointed and heavy penalties are imposed upon those who sell adulterated articles. We can hardly hope ever to have such strict regulations in regard to these matters in this country. The free-born citizen, especially if he be a manufacturer or dealer in suspected articles, naturally rebels against interference with his rights; and the manufacturer is not to be treated lightly. His voice is loud in the halls of legislation, and what *he* does not want the average legislator is pretty sure not to want. The relations with reference to food adulterations are similar to those existing with reference to fertilizers. The value of many fertilizers depends upon the amount of phosphoric acid and ammonia contained in them. I know that in some places there are chemists who habitually find considerably more phosphoric acid and more ammonia in any given fertilizer than it actually contains. If a young chemist dares to find the amounts actually present, and to state the results, the manufacturer discards them and takes the highest and false ones obtained by the initiated chemist. This can only be characterized by the name swindling. The public must submit. The manufacturer's interests are not to be trifled with. Looking at the subject of food adulterations from the stand-

point of the public, it can only appear highly desirable that some action should be taken by our State Governments looking to vigorous interference with the traffic in impure and injurious substances.

Having thus touched upon the general subjects of the relations of chemistry to Materia Medica and to Hygiene, it remains for me to consider briefly the relations between chemistry and medicine in a deeper and broader sense. We cannot at the present day, like our predecessors, regard medicine as a branch of chemistry. There are many kinds of action, not chemical, which must be studied and understood by the physician. Still, undoubtedly many of the physiological processes are essentially of a chemical nature, and there are many pathological phenomena which are also chemical. The complex organism which is the physician's field of work employs a variety of forces, prominent among which is the chemical force. It would be a trite remark to say that the physician can not possibly have a complete comprehension of what is going on within the body without a fair knowledge of chemistry. Yet I fear this fact is not always fully realized, nor indeed generally, if we are to take as evidence the practice of most medical schools.

Writing a quarter of a century ago, Liebig used these words, which I cannot do better than to repeat: "Physiological and chemical researches in the field of medicine are only in their infancy; but, scarcely begun, they have furnished the conviction . . . . . . that the processes in the living body rest upon natural laws, and every day brings discoveries which prove that these laws can be investigated. It is true that in ages gone by there were excellent physicians who knew nothing of anatomy, and that for centuries diseases have been cured the nature of which was not understood, just as to-day the nature of 'fever' and 'inflammation' is not known; but there is not the slightest foundation for the conclusion that an exact insight into these processes is impossible." And again he says: "Without correct ideas in regard to force, cause, action; without a practical insight into the nature of natural phenomena; without a thorough physiological and chemical training, it is no wonder that otherwise sensible men defend the most nonsensical views."

These words of Liebig are just as forcible to-day as the day they were written, and just as applicable.

The special value of a training in chemistry for a physician does not necessarily depend upon the fact that he learns a host of useful things, that he learns how to analyse substances, &c. To be sure, these acquisitions are valuable to him. But if chemistry is to do for him what it can do, he must work so long and so conscientiously in its field as to enable him to acquire the "chemical sense." He must learn to think in the language of chemistry. He must reason as chemists reason. Not as deeply of course, but in the same general way. Then chemistry will be to him a constant aid, whose presence he will feel whenever he is brought face to face with life, either in its normal or its abnormal forms.

But even if he did not retain a single chemical fact, the training which he would receive by going through a course in chemistry would be of value to him. His eye and mind would become somewhat accustomed to dealing with natural phenomena. His powers of observation would be exercised, and a certain ability to distinguish between the important and that which is secondary would be cultivated. With such preparation and other appropriate accompanying preparations, he would be much better able to undertake the study of medicine proper than without it. Hence it is much better to introduce the study of medicine by that of chemistry and other allied subjects, than to take up all the subjects together. The study of chemistry should form a part of the preliminary, fundamental training of every medical student.

That, owing to the arrangements of our medical schools, very little time can be given to chemistry, is a misfortune. The amount of the subject usually taught is scarcely worth the trouble of acquiring it. I know what the amount usually is. I remember distinctly that, on the occasion of my graduation as a Doctor of Medicine, I was asked six questions which any one who had ever looked at a text-book of chemistry could have answered. I answered most of the questions incorrectly, as I have since discovered, but the professor thought I was right, and I thought so too, and that was all that was necessary. Instead of possessing the "chemical sense," I was the possessor of considerable chemical nonsense.

But while it requires no arguments to prove that a chemical training is desirable for the physician, it is not sufficient simply

to acknowledge the truth of the statement. If it is true, then it is the sacred duty of every one who has any influence with those who have a medical career in view, to put them on the right track, to see that the best kind of preliminary training is furnished them. The opportunities for this training are not wanting in this country, nor are they wanting in this city.

By what I have said I do not mean to imply that the physician is to be a chemist. This is an impossibility. "No man can serve two masters." I mean simply that he should have sufficient chemical knowledge to enable him to see when chemistry can answer a question of importance to medical science, and to know what value to attach to a chemical fact. It is plain that this kind of knowledge, which, so to speak, should pervade the mind of the physician, can only be acquired by studying pure chemistry as a science, and not by taking up the special study of physiological chemistry or medical chemistry. These latter rest upon pure chemistry, and can only be studied intelligently upon this basis. The specialist in medicine does not study eye diseases or lung diseases or diseases of the nerves without first studying medicine. The analogy suggests itself.

But chemistry, even sufficient for the medical man, cannot be studied alone by means of lectures and text-books. The medical student should be brought in the laboratory in direct contact with the substances, the relations and properties of which he is studying. By this means alone can he learn enough of the subject to be of value to him; by this means alone can he get the peculiar training which leads to that kind of mind known as the "scientific mind" —a something which is tangible and attainable, and which should be a characterizing feature of every medical man.

Thus, gentlemen, I have spoken to you as a representative of the science of chemistry. I am sure you did not expect an oration, or you would have chosen an orator to speak on this occasion. I have endeavored to bring before you some matters of mutual interest to us. If I have exaggerated their importance, I regret it. If, on the other hand, I have succeeded in directing your attention to a few points which do not always receive the attention they deserve, I rejoice. At all events, I thank you heartily for the honor you have shown me in giving me an opportunity to speak before you.